PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 11363PC2	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. **PCT/AU2003/001270**	International Filing Date *(day/month/year)* 25 September 2003	Priority Date *(day/month/year)* 26 September 2002
International Patent Classification (IPC) or national classification and IPC **Int. Cl.** 7 G01N 22/00, 22/04		
Applicant CALLIDAN INSTRUMENTS PTY LTD et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

   [X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheet(s).

3. This report contains indications relating to the following items:

   - I [X] Basis of the report
   - II [ ] Priority
   - III [ ] Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV [ ] Lack of unity of invention
   - V [X] Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI [ ] Certain documents cited
   - VII [ ] Certain defects in the international application
   - VIII [ ] Certain observations on the international application

Date of submission of the demand 6 April 2004	Date of completion of the report 7 October 2004
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **RAJEEV DESHMUKH** Telephone No. (02) 6283 2145

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/AU2003/001270

I. Basis of the report

1. With regard to the **elements** of the international application:*

- [ ] the international application as originally filed.
- [X] the description, pages **1–31,** as originally filed,
  - pages , filed with the demand,
  - pages , received on with the letter of
- [X] the claims, pages , as originally filed,
  - pages , as amended (together with any statement) under Article 19,
  - pages , filed with the demand,
  - pages **32–37,** received on **29 September 2004** with the letter of **29 September 2004**
- [X] the drawings, pages **1/6–6/6,** as originally filed,
  - pages , filed with the demand,
  - pages , received on with the letter of
- [ ] the sequence listing part of the description:
  - pages , as originally filed
  - pages , filed with the demand
  - pages , received on with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

- [ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- [ ] the language of publication of the international application (under Rule 48.3(b)).
- [ ] the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- [ ] contained in the international application in written form.
- [ ] filed together with the international application in computer readable form.
- [ ] furnished subsequently to this Authority in written form.
- [ ] furnished subsequently to this Authority in computer readable form.
- [ ] The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- [ ] The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. [ ] The amendments have resulted in the cancellation of:

- [ ] the description, pages
- [ ] the claims, Nos.
- [ ] the drawings, sheets/fig.

5. [ ] This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims **1-32**	**YES**
	Claims	**NO**
Inventive step (IS)	Claims **1-32**	**YES**
	Claims	**NO**
Industrial applicability (IA)	Claims **1-32**	**YES**
	Claims	**NO**

2. Citations and explanations (Rule 70.7)

US 4788853 A (BELL) 6 December 1988 discloses a moisture meter and a method for determining moisture content in a mass of material. BELL cites *"a change in the **height** of the bed of material"*—column 2, lines 2–3—as a problem of the prior art. BELL employs a source of microwave radiation *"capable of emitting a **scan** of different frequencies"*—column 2, lines 27–28. *"The **frequency band** chosen is conveniently in the range of 0.1 to 20 GHz, ... but **this may be chosen according to the material and its expected moisture content**"*—column 2, lines 35–40. *"The material being subjected to microwave radiation is **suitably coal**, but any other material which does not exhibit significant attenuation of microwave radiation in the relevant waveband may be considered. These materials may include **other minerals, unprocessed or processed vegetable matter, for example grain, products of or feedstocks for the chemical industry and the like.**"*—column 3, lines 8–14. *"The support for the sample may be a rotatable table ... or a static sample cell, but the present invention may be applied also to **a conveyor belt, thus offering the possibility of on-line moisture monitoring**"*—column 3, lines 64–68. *"It is preferred also to provide to the microprocessor data on the density and **thickness of the material**. We have discovered that there is a direct and linear correlation between attenuation and both the density and the bed depth of e.g., a coal sample, i.e. the mass of the sample. It is therefore possible for the micro-processor to access this data and incorporate correction factors **without the previously recommended attempts to obtain a constant bed depth** and packing density, which tended to be expensive and complex in equipment and/or operator time. Such data may be obtained by methods known per se, including mechanical height measurement, e.g. using a trailing arm, **ultrasonic ranging** or optical (including infra-red) rangefinding techniques, and sample weights may be found e.g., by conventional belt weighers"*—column 2, line 57–column 4, line 3.

The cited document neither discloses nor suggests the invention as claimed in claims 1–32 wherein the microwave generator generates a *continuous linearly sweeping* microwave signal varying in frequency and the microwave analyser is capable of measuring the phase shift and/or attenuation of the amplitude of the microwave signal by *random stratified sampling* of the received signal. Therefore the claimed invention is novel, involves an inventive step, and is industrially applicable.

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CLAIMS

1. A sample analysis apparatus that measures an amount of at least one component in a sample comprising:

(i) a microwave generator that generates a continuous linearly sweeping microwave signal varying in frequency;

(ii) a microwave transmitter that transmits the generated signal;

(iii) a microwave receiver that receives the transmitted signal;

(iv) at least one microwave analyser that generates an output signal, which is operatively connected to the microwave transmitter and to the microwave receiver; said output signal indicating a phase shift and/or an attenuation of amplitude of the microwave signal when comparing the generated signal and the received signal, and the at least one microwave analyser is capable of measuring the phase shift and/or attenuation of the amplitude of the microwave signal by random stratified sampling of the received signal;

(v) means for determining a depth of the sample located between said microwave transmitter and said microwave receiver; and

(vi) a processor that determines the amount of said at least one component in said sample from said depth and said output signal.

2. The apparatus of claim 1 wherein said means for determining a depth of the sample comprises a sample depth analyser that measures depth of the sample.

3. The apparatus of claim 2 wherein the sample depth analyser is

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an ultra-sonic transmitting device.

4. The apparatus of claim 1 wherein the continuous linearly sweeping microwave signal varies in frequency between a range of about 0.10 GHz to 4.00 GHz.

5. The method of claim 4 wherein the continuous linearly sweeping microwave signal varies in frequency between a range inclusive of 1.25 GHz to 1.65 GHz.

6. The apparatus of claim 1 wherein the transmitter and receiver comprise respective antennas.

7. The apparatus of claim 1 wherein the microwave analyser comprises a microwave mixer that measures phase shift by receiving a portion of the transmitted signal and a portion of the received signal.

8. The apparatus of claim 7 wherein the microwave mixer generates an output signal comprising an oscillating voltage with a DC bias and frequency wherein a change in the DC bias or frequency is proportional to a change in velocity of the transmitted signal and provides a measure of a change in overall dielectric constant of the component in the sample.

9. The apparatus of claim 1 wherein the microwave analyser comprises a microwave amplitude detector that measures an amplitude of the received signal.

10. The apparatus of claim 1 wherein the random stratified sampling is performed using an algorithm programmed into the processor.

11. The apparatus of claim 1 wherein the processor is a microprocessor.

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12. The apparatus of claim 1 wherein the component in the sample is water, carbon, salt, fat or protein.

13. The apparatus of claim 12 wherein an amount of water in the sample is determined using the equation:

Moisture content = M0 +M1*(Attenuation/Depth of sample) + M2*(Velocity/Depth of sample)+M3*(Velocity/ Depth of sample)^2 + M4*(Attenuation/ Depth of sample)^2; wherein

Attenuation = (amplitude measured with sample) - (amplitude measured without sample);

Velocity = (microwave velocity measurement with sample) – (microwave velocity measurement without sample); and

Depth of sample = (Depth with sample) - (depth without sample); and

M0, M1, M2, M3 and M4 are calibration coefficients determined by performing a simple linear regression of variables: (Attenuation/Depth of sample), (Velocity/Depth of sample), (Velocity/ Depth of sample)^2 and (Attenuation/ Depth of sample)2 against experimentally determined values for the component.

14. The apparatus of claim 13 wherein M0 = 0.475, M1 = 208.117, M2 = -0.04454, M3 = 0 and M4 = 0.

15. A method for measuring an amount of at least one component in a sample including the steps of:

(1) generating a continuous linearly sweeping microwave signal varying in frequency;

(2) transmitting the generated signal;

(3) receiving a received signal;

(4) measuring and analysing the generated signal and the received signal and generating an output signal; said output signal indicating phase and/or amplitude differences between the generated signal and the received signal;

(5) measuring a depth of the sample to provide a sample depth measurement; and

(6) processing the output signal and the sample depth measurement to determine the amount of the component in the sample.

16. The method of claim 15 wherein the continuous linearly sweeping microwave signal varies in frequency between a range of about 0.10 GHz to 4.00 GHz.

17. The method of claim 16 wherein the continuous linearly sweeping microwave signal varies in frequency between a range inclusive of 1.25 GHz to 1.65 GHz.

18. The method of claim 17 wherein the steps of transmitting and receiving signals is by respective antennas.

19. The method of claim 15 wherein phase shift is measured by a microwave mixer that receives a portion of the generated signal and a portion of the received signal.

20. The method of claim 19 wherein the output signal comprises an oscillating voltage with a DC bias that is proportional to both a change in microwave velocity and phase shift.

21. The method of claim 15 wherein attenuation of an amplitude of the generated signal is measured by an amplitude detector.

22. The method of claim 15 wherein the phase and/ amplitude differences are measured by random stratified sampling of the received signal.

23. The method of claim 21 wherein the random stratified sampling is performed using an algorithm within a processor.

24. The method of claim 15 wherein the step of measuring a depth of the sample is by an ultra-sonic means.

25. The method of claim 15 wherein the processing is performed by a microprocessor.

26. The method of claim 15 wherein the component in the sample is water, carbon, fat, salt or protein.

27. The method of claim 26 wherein an amount of water in the sample is determined using the equation:

Moisture content = M0 +M1*(Attenuation/Depth of sample) + M2*(Velocity/Depth of sample)+M3*(Velocity/ Depth of sample)^2 + M4*(Attenuation/ Depth of sample)^2; wherein

Attenuation = (amplitude measured with sample) - (amplitude measured without sample);

Velocity = (microwave velocity measurement with sample) – (microwave velocity measurement without sample); and

Depth of sample = (Depth with sample) - (depth without sample); and

M0, M1, M2, M3 and M4 are calibration coefficients that are

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determined by performing a simple linear regression of the variables: (Attenuation/Depth of sample), (Velocity/Depth of sample), (Velocity/ Depth of sample)^2 and (Attenuation/ Depth of sample)^2 against experimentally determined values for the component.

28. The method of claim 27 wherein M0 = 0.475, M1 = 208.117, M2 = -0.04454, M3 = 0 and M4 = 0.

29. Use of the apparatus of claim 1 to determine an amount of at least one component in a sample.

30. Use of the apparatus of claim 29 wherein the at least one component modifies the generated signal.

31. Use of the apparatus of claim 30 wherein the at least one component is water, carbon, salt, fat or protein.

32. Use of the apparatus of claim 29 where the sample is an ore, mineral, coal, flyash, nickel ore, alumina; chromium ore, wood chip; bulk food, textile, chemical, food product, sugar, pasta, coffee, peanuts, wheat, barley, beef jerky, kitty litter, paper, polystyrene or plastic.